OTHER ENVIRONMENTAL PROGRAMS

PROGRESS REPORT - 4

Prepared for:

The Rio Blanco Oil Shale Project

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TABLE OF CONTENTS

LIST OF TABLES

2.5 Other Environmental Programs

2.5.1 Soils survey and productivity assessment studies

2.5.1.1 Objectives

The soil studies are designed to fulfill the requirements of the oil shale lease, provide data necessary in the determination of ecosystem relationships and provide information required during revegetation studies.

The objectives of the soil survey are to describe and map soil types. Soil types, depths of the various layers of soil, strike and dip of the soil, slopes, vegetation cover and erodibility are described.

Consult Progress Report 2, Section 2.5.1.1 for additional objectives of the soils program.

2.5.1.2 Methods

Methods employed in the soil studies are described in Section 2.5.1.2 of Progress Report 2.

2.5.1.3 Results

Preliminary soil surveying and mapping has been carried out by the Soil Conservation Service (SCS). A preliminary soils map has been prepared by the SCS and is currently undergoing further revisions. A general description of the twelve soil types encountered during surveying and mapping by the SCS are discussed below.

The aridic haploboroll, loamy-skeletal, mixed, unnamed series consists of moderately deep, well-drained soils that formed in colluvium on foothill sideslopes. These soils have slopes of 12 to 50 percent. Mean annual precipitation is about 46 cm (18 inches), and the mean annual temperature is about 5 to 6 C (42 F). The typical pedon is channery loam, 12 to 60 percent slopes, SW¼ NW¼ Section 10, T1N, R99W.

The Forelle series consists of deep, well-drained soils that formed in calcareous aeolian sediments. Forelle soils are on uplands and terrace slopes and have slopes of 3 to 15 percent. Mean annual precipitation is about 35 to 46 cm (14 to 18 inches), and mean annual air temperature is about 5 to 6 C (42 F). Forelle soils are similar to the Piceance and Yamac soils. Piceance soils have a lithic contact less than 100 cm (40 inches). Yamac soils do not have an argillic horizon. Typical pedon of Forelle loam, 3 to 25 percent slopes, about 0.5 km (0.3 mile) east and 0.3 km (0.2 mile) south of the northwest corner of Section 30, T1N, R93W.

The Glendive series consists of deep, well-drained soils formed in alluvial materials. Glendive soils are in valley positions and have slopes of 2 to 9 percent. Mean annual precipitation is about 35 cm (14 inches), and mean annual air temperature is about 6 C (43 F). Glendive soils are near the Hagga, Havre and Hanly soils. Hagga soils are poorly drained; Hanly soils have a sandy control section; and Havre soils are finer textured than the Glendive soils. Typical pedon of Glendive fine sandy loam, 2 to 9 percent slopes, about 90 m (100 yards) south of the Ryan Gulch Road and 15 m (50 feet) east of the fence in the NE¼ of NE¼ Section 12, T2S, R98W.

The Hagga series consists of deep, very poorly-drained soils that formed in alluvium derived mainly from calcarious sandstones and shales. Hagga soils are on valley bottoms and have slopes of 0 to 5 percent. The mean annual precipitation is about 40 cm (16 inches), and the mean annual temperature is about 7 C (45 F). Hagga soils are similar to the Buford and Havre soils. Buford soils have dark surfaces and have very gravelly substrata. Havre soils are well drained to moderately well drained, lacking mottles above a depth of 100 cm (approximately 40 inches). Typical pedon of Hagga loam, 0 to 5 percent slopes, 45 m (150 feet) south and 49 m (160 feet} west of northwest corner of Section 5, T3S, R96W 53 m (175 feet) southwest of Stuart Gulch gaging station).

The Hanly series consists of deep, somewhat excessively drained soils that have formed in detrital alluvium of calcareous sandstone and shale origin. Hanly soils are on alluvial fans and in narrow valleys with slope gradients of 2 to 9 percent. Mean annual precipitation is about 15 cm (6 inches), and the mean annual air temperature is about 7 C (45 F). Hanly soils are similar to the Glendive soils with which they are closely associated. Glendive soils differ in being mainly sandy loam at 25 to 100 cm (approximately 10 to 40 inch) depths. Typical pedon of Hanly gravelly loamy fine sand, 2 to 9 percent slopes, 2.4 km (1.5 miles) up Ryan Gulch, 60 m (200 feet) north of road, in the SE¼ of SE¼ Section 31, T1S, R98W.

The Havre series consists of deep, well-drained soils that formed in calcareous mixed alluvium. Havre soils are on floodplains and low terraces and have slopes of 0 to 8 percent. Mean annual precipitation is about 40 cm (16 inches), and the mean annual air temperature is about 6 to 7 C (44 F). Havre soils are similar to Uffens, Glending, Youngston, Hagga, Hanly and Glendive. Uffens soils are natric and saline in reaction. Glending and Youngston occur in a warmer temperature zone. Glending, Hanly and Glendive have sandier control sections. Hagga soils are poorly drained. Typical pedon of Havre loam, 0 to 8 percent slopes, 0.6 km (0.4 mile) south, 60 m (200 feet) east of the NW corner of Section 32, T1N, R94W.

The lithic haploboroll, loamy-skeletal, mixed, unnamed series consists of shallow, well-drained soils that formed in sandstone residuum on upland slopes and ridge tops. These soils have slopes of 5 to 50 percent. Mean annual precipitation is about 46 cm (18 inches), and the mean annual air temperature is about 5 to 6 C (42 F). The typical pedon is very channery loam, 5 to 50 percent slopes, NE¼ NW¼ Section 22, T1N, R99W.

The Piceance series consists of moderately deep, well-drained soils that formed in residuum from sandstone and modified with aeolian material. Piceance soils are on upland slopes and ridges and have slopes of 5 to 15 percent. Mean annual precipitation is about 35 to 46 cm (14 to 18 inches), and the mean annual air temperature is about 6C (43 F). Piceance soils are similar to Forelle, Yamac and Kinnear. Forelle, Yamac and Kinnear soils are deep and do not have bedrock above 100 cm (approximately 40 inches). Kinnear soils occur in a warmer temperature zone. Typical pedon of Piceance fine sandy loam, 5 to 25 percent, NE¼ of NE¼ Section 33, T2S, R99W.

The Redcreek series consists of shallow, well-drained soils that formed in sandy material weathered from underlying calcareous sandstone. Redcreek soils are on mountain sideslopes and ridges and have slopes of 5 to 30 percent. Mean annual precipitation is about 40 cm (16 inches), and the mean annual air temperature is about 6 to 7 C (44 F). Redcreek soils are similar to the Rentsac soils. Rentsac soils are skeletal and are on fractured sandstone, while Redcreek soils are non-skeletal and are on massive sandstone. Typical pedon of Redcreek sandy loam, 5 to 30 percent slopes, about 275 m (900 feet) N of SW¼ corner, Section 18, Township 3 South, R96W.

The Rentsac series consists of shallow, well-drained soils formed in residuum from sandstone. Rentsac soils are on foothills (upland entrenched terrace) and have slopes which are 5 to 50 percent. Mean annual precipitation is 40 cm (approximately 16 inches), and the mean annual air temperature is about 6 to 7 C (44 F). Rentsac soils are similar to the Redcreek soils. Redcreek soil is non-skeletal, while Rentsac is skeletal. Typical pedon of Rentsac very channery sandy loam, 5 to 50 percent slopes, under chained pinyon-juniper area, NE¼ SW¼, Section 27, Township 1 North, R98W.

Rock outcrop-Torriorthents, 12 to 90 percent slopes (RT) occurs mainly on southerly aspects in the Piceance Basin on strongly sloping to extremely steep terrace breaks of the many drainageways of this area. Rock outcrop occurs as horizontal sandstone cliffs or dike-like outcrops and as platy siltstone outcrops in 50 to 65 percent of the mapping unit. The remainder of the mapping unit is comprised of Torriorthents, most of which are very shallow and shallow, and a small percentage of moderately

deep and deep Torriorthents in the colluvial and alluvial material. The vegetation is characterisitcally very sparse - few scattered pinyons, junipers and shrubs. These soils have a severe limitation for sanitary facilities and local roads due to shallowness of the soil. These soils are a poor source of material for roadfill and topsoil due to thin layer, small stones and problems of area reclamation.

The Yamac series consists of deep, well-drained soils that formed in alluvium and aeolian materials. Yamac soils are on rolling uplands and ridges and have slopes of 5 to 15 percent. Mean annual precipitation is about 36 cm (14 inches), and mean annual air temperature is about 6 to 7 C (44 F). Yamac soils are similar to the Forelle and Piceance soils. Forelle soils have an argillic horizon not found in the Yamac. Piceance soils overlie bedrock at 50 to 100 cm (approximately 20 to 40 inch) depths. Typical pedon of Yamac loam, 5 to 15 percent slopes, SW¼ of Section 2, T2S, R99W.

The SCS is processing soils for trace element and mechanical analysis.

The selection of a soils contractor is currently being made and the initiation of the program will be started immediately upon contract award. This program will include collection and analysis of soil samples associated with major vegetation types. Trace metal concentrations will be determined and soil/plant relationships will be interpreted.

2.5.2 Archaeological survey

2.5.2.1 Objectives

The archaeological survey was designed to locate archaeological or historical material on Tract C-a, a mile-wide perimeter around the tract and 84 Mesa. The survey was then extended downstream on several drainages, particularly Yellow Creek, to obtain more information on off-tract sites.

The survey was designed to obtain information on the extent of occupation, cultural affiliations, time depth represented and native exploitation of the region. Material found during this study was compared with that described from other areas, particularly the Douglas Creek drainage.

Comparison of artifacts found on Tract C-a was also made with collections held by local individuals, many of whom have been collecting artifacts from the area for many years. The procedure prevented inadvertent omission of scarce or commonly sought after items such as projectile points (arrowheads).

The past existence of trade relationships between local inhabitants and those from areas outside the basin was explored. Evidence that trade had been conducted was revealed by the presence of pottery that had not been locally made and the presence of imported toolstone. These artifacts suggested a widespread contact with areas outside the Piceance Basin.

2.5.2.2 Methods

Two types of ground surface surveys were employed during the investigations. No excavations were done. Both surveys involved systematic walk-overs of the area and collection of artifacts. The following data were recorded for each located collection: field number and distinctive features of the site (such as terrain or structures). Each find was labeled and kept separate from others.

In rough or broken ground, areas that could have been occupied such as benches adjacent to drainages, areas near springs or streams and upland areas that might have been used for hunting or gathering camps were intensively searched. Areas that have produced artifacts in the past were also carefully searched.

In relatively featureless terrain such as 84 Mesa and the alluvial valley floors, team members were spaced a short distance and the area was systematically traversed with team members searching for artifacts.

When artifacts were found, the team then concentrated on that area and collected as much material as could be located. The

search was continued until no more artifacts or chips were found.

After early surveys had progressed sufficiently, information gathered in the field was processed. Types of artifacts obtained and the locations of sites were itemized and mapped, and the emerging pattern of site locations was used to direct the investigation into areas in which the probability of finding additional sites was greatest. This technique prompted surveying down into the more productive lower drainages rather than moving up the drainages toward the less productive Cathedral Bluffs. While the high uplands were probably utilized to some extent, the majority of camp locations were on lower ground.

Material recovered in the field was processed in the base station laboratory. Artifacts were washed, labeled with field numbers, identified and recorded. Both site locations and non-productive areas were plotted at the end of each field day.

The initial survey followed the priority system delineated in Figure 2.5.2-1. After this area had been cleared for the presence or absence of sites, the survey was expanded to the areas shown in Figures 2.5.2-2,3 and 4.

In addition to surveys and collections on site, several private collections and museums in Meeker and Dinosaur National Monument were inspected to provide additional background on the archaeological history of the area. A number of caves and overhangs which offered protection and were probable wintering areas for people who utilized the Piceance Basin are found in the Douglas Creek area. One of the most distinctive features of shelters in the Douglas Creek drainage is the amount of rock art. It includes pictographs painted on the walls and petroglyphs which are not painted but are pecked into the rock face. These include depictions of humans, various animals and designs. A similar area with three caves north of Rangely was also inspected.

2.5.2.3 Results

A total of 196 locations produced material that was transported into the area, or modified, by man. These ranged from a single flake of toolstone to concentrations of tools, broken or discarded pieces and wastage associated with the manufacture of tools. The material used for chipped tools included chalcedony, jasper, petrified wood, obsidian and quartzite. These materials are fine grained and were worked by flaking. During tool production, small chips were often discarded if they were too small to serve as secondary tools. This wastage is usually a good indication that an area was once occupied. The color and texture of small tools or flakes found in the study area were quite different from the local shales and sandstones. Since the local stone cannot be worked to produce functional small tools, it is likely that toolstone was imported by the inhabitants. There

ENVIRONMENTAL STUDIES FOR THE RIO BLANCO OIL SHALE PROJECT

TRACT C-a

LIMNETICS, INC.
Denver, Colorado

4/75

ARCHEOLOGICAL SURVEY

999 indicates priority for performance and reporting requirements

84 Mesa spent shale disposal site

--- one mile perimeter of Tract

SURVEYS COMPLETED AS OF JUNE 30, 1975

MILES
0 1 2

N

Figure 2.5.2–1

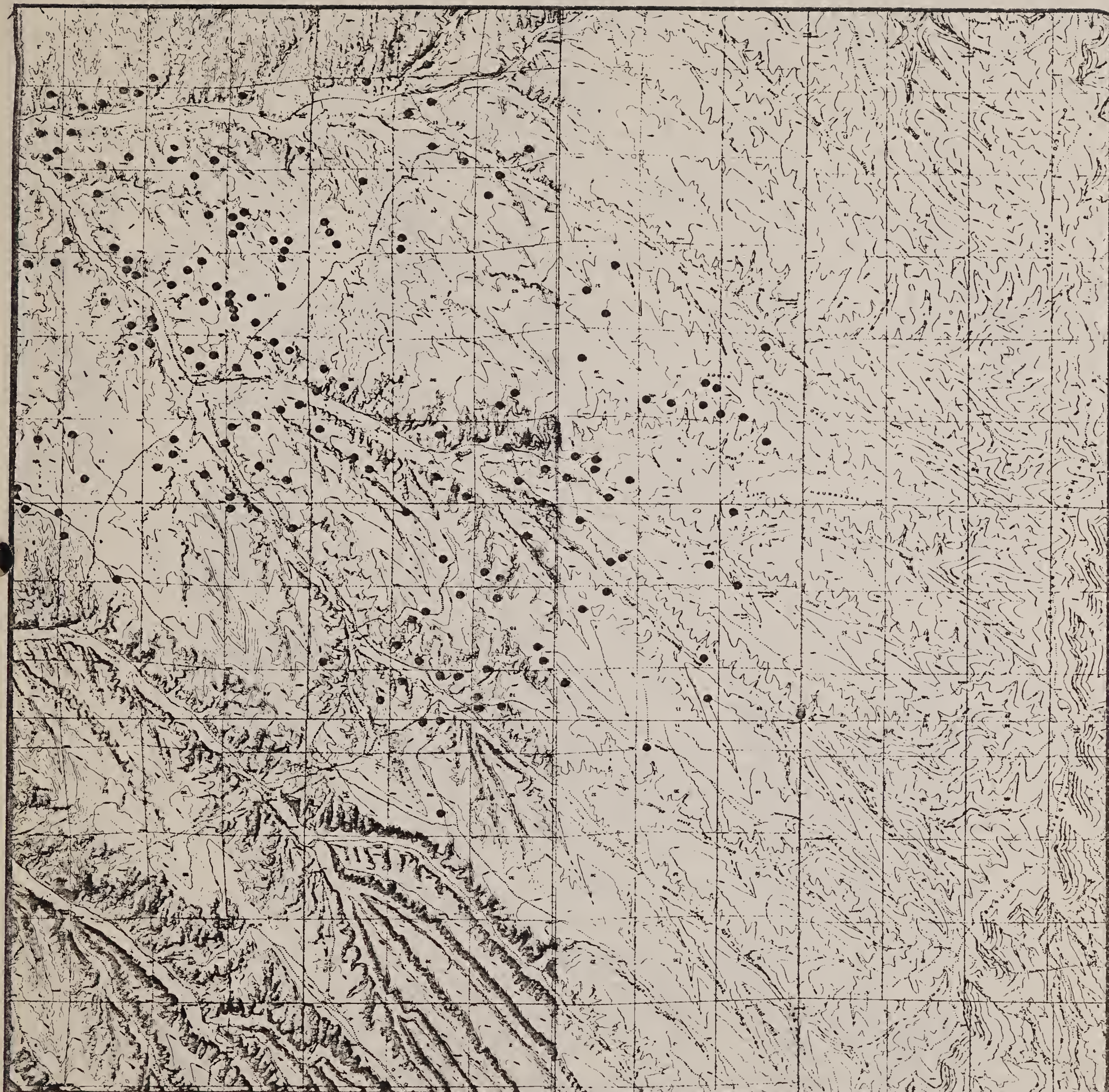


Figure 2.5.2–2 Expanded Archaeological Survey Area.

Dots represent areas surveyed.

Figure 2.5.2–3 Expanded Archaeological Survey.

Dots represent areas surveyed.

Figure 2.5.2–4 Expanded Survey Area.

Dots represent areas surveyed.

was some use of local stone for larger tools such as choppers and grinding stones. Suitable toolstone supplies are present in the main White River drainage, west into Utah, and in southwestern Wyoming. No quarry sources for toolstone were found during the survey.

Tools used for grinding various vegetal products were also found in the area. The lower element of these tools, the grinding slab, was usually an oval or irregular slab of local sandstone characterized by a depression that had been formed through long use. The handstone, or moveable element, was fashioned from a thin, oval stream cobble. These were of a size that could conveniently be held in one hand. Evidence from this historic period indicates that these tools were used to grind various types of seeds, to hull pinyon nuts, and even in some instances to grind dried meat. Cooking techniques during this period included preparation of liquid or mush foods. Another use of these tools was to grind pigments that could have been used for body painting, decoration of portable objects or painting of pictographs.

The sites that were found in the survey are classed as open sites. Open sites are located in areas in which there is no physical protection other than variations in the terrain. Few caves or overhangs were found, and those investigated did not appear to have been occupied. Camping in the open, which would suggest good weather, was common. Open sites, however, usually yield few artifacts because organic decay, insect or bacterial action and oxidation quickly destroy all but the most durable artifacts. Those found are lithic or stone artifacts. The samples collected during the survey consisted almost entirely of items made from stone. In prehistoric times, tools were often made of many other materials such as wood, bone, antler, horn and plant products that produced fibers or other useful elements. No artifacts made from these perishable materials were found. Unworked bone is scattered through the area, but this is probably a result of hunting activity and winter kills.

A few pieces of broken pottery were found that may have been imported from the Mesa Verde region or from the west, in Utah, and the northwest, in Dinosaur National Monument.

Several classes of artifacts were collected, including projectile points. These are good diagnostic artifacts, as their shapes and chipping design are regionally and temporally distinctive. Most points in the collection exhibit additional modification for attaching to a weapon shaft, including notching or definite base design to hold the sinew used to tie the point on. Broken points (probably discarded at camp sites and replaced with whole new points) are also part of the collection. Careful workmanship and chipping on all edges and both sides of the point are common to the tools in the collection. Good grade (glassy) toolstone was used.

Two types of projectiles were found (Figure 2.5.2-5). The larger projectiles are classified as dart points used for attachment to a short, spear-like shaft. These weapons were usually thrown from a spear thrower, a weapon approximately 2 inches wide and 18 inches long. The other type of projectile points are much smaller and are classified as arrow points. These would indicate use of the bow and arrow. Use of the bow succeeded use of the spear thrower, although there may have been an overlap in their use.

Knives are defined as processing tools that were chipped on both sides to produce a wedge-shaped cutting edge. These were probably primarily used for cutting meat, working hides and for cutting other materials. Two types of knives were made. One was a finished tool with distinct shapes and dimensions. These were fabricated by chipping both the edges and the faces. The other type of knife was merely a flake which was used until it dulled, then discarded. These flakes have extremely sharp edges, much more so than a chipped knife, but the edges are extremely fragile and not very durable. Although knives could have been used to scrape objects, the wear pattern is similar to that produced on steel knives. Drawings of knives found on Tract C-a are shown in Figure 2.5.2-5 and 6.

Scrapers were used to remove unwanted material from hides and other materials. The edge of a scraper differs from that of a knife in that it was chipped away from the edge, giving it an angular surface. Finished scrapers have one flat side and a rounded or convex upper surface. Chips or flakes were sometimes used as scrapers for a particular task and then discarded. Most of the scrapers found in the survey (Figure 2.5.2-6) were too small to have been attached to a handle and were probably held in the fingers. Flakes, while indicative of occupation, are usually not good diagnostic artifacts unless they were used secondarily as tools such as knives or scrapers. Unfortunately, they do not aid in temporal or cultural identification, but their abundance and distribution are good indicators of the amount of occupation at a given site.

Metates (grinding slabs) and manos (handstones) were used for grinding food to a meal or powder. Drills and punches are similar tools to ones in our culture, except that they were made of stone. Cores are the remnants of toolstone from which flakes have been removed. They are not usually tools in themselves. Hammerstones are more or less spherical pieces of tough stone that were used to fabricate or process other materials. Hammerstones were used to shape manos and metates. Choppers are large chipped-edge tools that were used to chop or part various materials. They could have been used in butchering coarse fabrication, or working any non-stone material.

The initial list of tool types and site locations is shown in Tables 2.5.2-1 through 2.5.2-4 for Tract C-a, the 1-mile perimeter, 84 Mesa and off-tract sites.

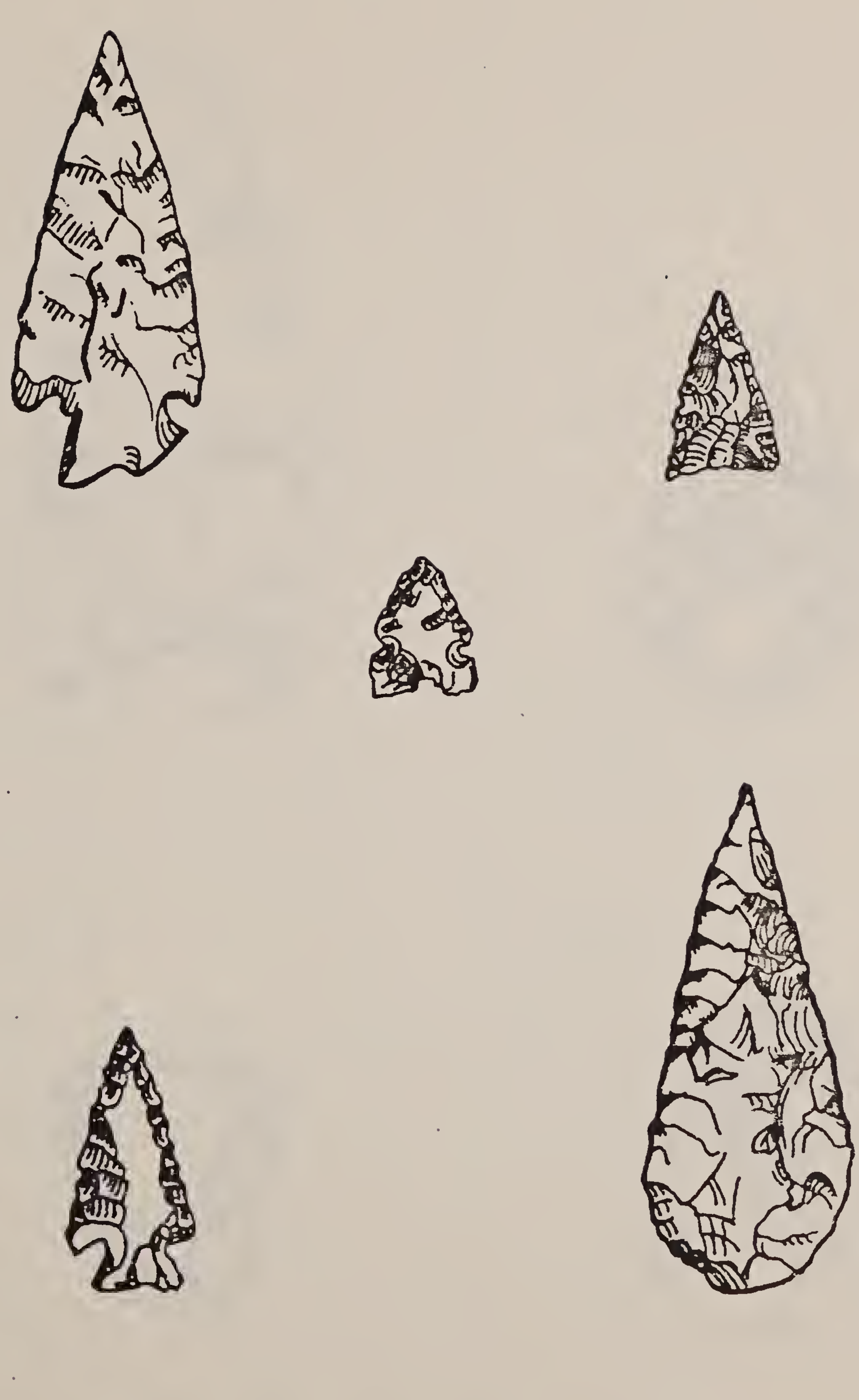


Figure 2.5.2-5 Projectile points and a knife from Tract C-a, RBOSP. Upper right Archaic projectile point, remainder Fremont. Lower right, knife.

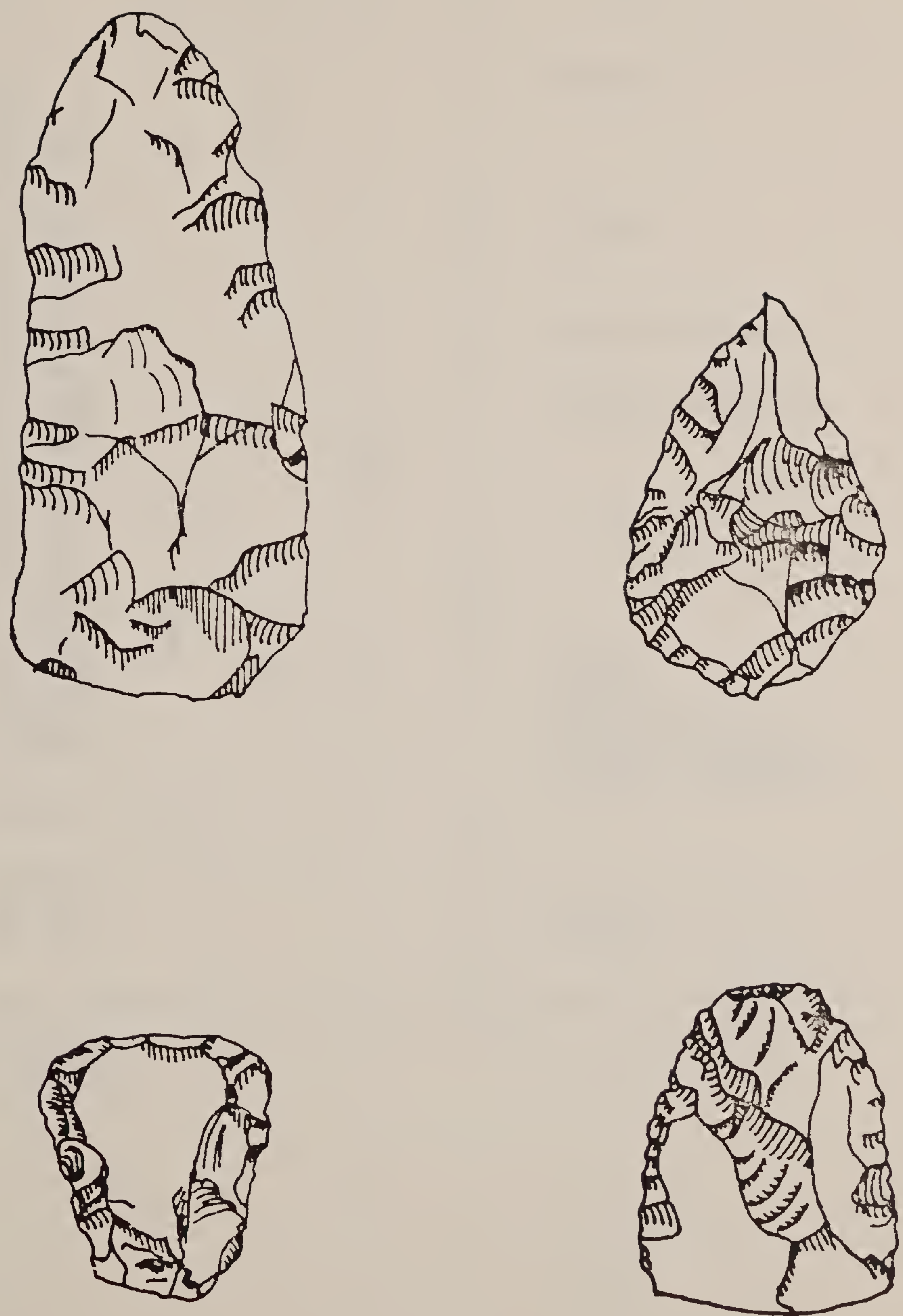


Figure 2.5.2-6 Knives and scrapers from Tract C-a RBOSP. Upper row knives, lower row scrapers.

Table 2.5.2-1 Field site number, site location and initial material culture analysis located June through September 1975 on Tract C-a, RBOSP.

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
4	T2S,	R99W	S3 , NW¼		1f*		3	Metate
5	T1S,	R99W	S34, SW¼ NE¼		1f			
6	T1S,	R99W	S33, SE¼ NW¼	1f	1f			
7	T2S,	R99W	S4 , NW¼ NE¼		1f	2	12	
8	T1S,	R99W	S34, NW¼ SW¼					Punch
9	T1S,	R99W	S33, NW¼ SW¼				3	
14	T2S,	R99W	S4 , NE¼ SE¼			1		
15	T1S,	R99W	S34, SE¼ SW¼				7	Tool fragment
16	T1S,	R99W	S34, SW¼ SW¼			1	2	
29	T2S,	R99W	S4 , NE¼ SE¼					Tool fragment
33	T1S,	R99W	S33, SE¼ SW¼			1f		
34	T1S,	R99W	S33, SW¼ NE¼			1f		
37	T2S,	R99W	S10, NW¼ SW¼	1f				
38	T2S,	R99W	S9 , NW¼ SW¼				1	
39	T2S,	R99W	S10, SW¼ SW¼				2	
40	T2S,	R99W	S10, NW¼ NE¼	1			1	
41	T2S,	R99W	S3 , SE¼ SE¼	1	2f	6	2	Drill
42	T2S,	R99W	S3 , SW¼ SE¼					Metate
43	T2S,	R99W	S9 , NE¼ NW¼					Mano fragment 2 tool fragments
45	T1S,	R99W	S33, NE¼ SE¼	1				
				1f			12	
51	T2S,	R99W	S10, SE¼ SE¼				1	
54	T2S,	R99W	S3 , NW¼ SW¼				3	Core

* Identifiable fragmentary tool

Table 2.5.2-2 Field site number, site location and initial material culture analysis for archaeological sites located June through September 1975 in the 1-mile perimeter of Tract C-a, RBOSP.

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
10	T1S,	R99W	S29, NW¼ SW¼				1	
11	T1S,	R99W	S29, SW¼ SW¼			1	1	
12	T1S,	R99W	S29, SW¼ SE¼			1	4	
13	T1S,	R99W	S29, NW¼ SW¼		1f*		1	Drill
20	T2S,	R99W	S14, NW¼ NW¼	2	4f	1	51	
21	T2S,	R99W	S15, SW¼ NE¼		1		13	
25	T1S,	R99W	S27, SW¼ SE¼		2f	1	6	
28	T2S,	R99W	S11, SW¼ SW¼				1	
30	T2S,	R99W	S17, SE¼ SE¼	1f		2	20	
32	T1S,	R99W	S27, NE¼ SW¼			1f	16	
35	T2S,	R99W	S11, SW¼ NE¼				2	
36	T2S,	R99W	S11, NE¼ SE¼	1f		3f	20	Hammerstone fragment
44	T2S,	R99W	S17, SW¼ NW¼	1			1	
47	T1S,	R99W	S35, NE¼ NW¼		1f		22	
50	T2S,	R99W	S16, NE¼ NE¼				2	
52	T2S,	R99W	S15, SW¼ NE¼		1		5	
53	T2S,	R99W	S6 , SW¼ NE¼				1	Tool stone
55	T2S,	R99W	S15, SW¼ NE¼	2f			5	Mano fragment
56	T2S,	R99W	S6 , SW¼ SE¼	1				
				1f	3f			Mano, fossils
64	T2S,	R99W	S14, NW¼ SE¼	2f	3f			
65	T2S,	R99W	S14, NW¼ NW¼	1				Hammerstone
				2f		1f	110	Mano fragment
66	T2S,	R99W	S14, NE¼ NW¼	2f			35	
67	T2S,	R99W	S11, SW¼ SE¼				11	
70	T2S,	R99W	S11, SW¼ SW¼					Toolstone
71	T2S,	R99W	S11, NW¼ NW¼				9	
72	T2S,	R99W	S2 , NE¼ SW¼			1		
81	T2S,	R99W	S2 , NE¼ NE¼	1				
				2f			2	Chopper
82	T1S,	R99W	S35, SW¼ SW¼				2	Mano fragment
83	T1S,	R99W	S35, SW¼ SW¼					Mano
84	T1S,	R99W	S35, NE¼ SE¼	2f		2f	24	3 Mano fragments Hammerstone

Table 2.5.2-2 (Continued)

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
94	T1S,	R99W	S29, NW¼ SW¼		4f	2		
						1f	13	
95	T1S,	R99W	S28, SW¼ NE¼	1f			2	
97	T1S,	R99W	S30, NE¼ NW¼					Tool stone
103	T1S,	R99W	S30, SE¼ SE¼				3	
104	T1S,	R99W	S31, SE¼ NW¼				1	

* Identifiable fragmentary tool

Table 2.5.2-3 Field site number, site location and initial material culture analysis for archaeological sites located June through September 1975 on 84 Mesa, RBOSP.

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
3	T1S,	R99W	S36, NW¼ SW¼	1f*	1f		5	
17	T1S,	R98W	S18, SE¼ SW¼		1f	3f	6	
18	T1S,	R98W	S18, SE¼ SW¼	1				
				2f	1f	1f	67	
21	T1S,	R99W	S25, SE¼ NE¼	1	1f		3	Mano, Metate
22	T1S,	R98W	S18, SE¼ SW¼				9	
23	T1S,	R98W	S30, NW¼ NE¼	3	1			
				8f	2f		215	Hammerstone, drill, 3 choppers
24	T1S,	R99W	S25, NW¼ SE¼	1f			147	3 Mano fragments
26	T1S,	R98W	S20, NW¼ SW¼	1	2f	2f	1	
27	T1S,	R98W	S30, SE¼ NE¼	2f			54	Potsherds, scrapers, knives, blades
31	T1S,	R98W	S30, SE¼ NW¼	2			1	
46	T1S,	R98W	S8 , SW¼ SW¼	1f			20	1 historic knife, hammerstone, 5 Mano fragments, chopper, drill
48	T1S,	R98W	S19, SW¼ NW¼	1			2	
49	T1S,	R98W	S19, NW¼ SE¼	1f			3	
57	T1S,	R98W	S19, NE¼ SE¼				74	
58	T1S,	R98W	S20, SW¼ NW¼				3	1 potsherd
59	T1S,	R98W	S20, SE¼ NW¼					Mano fragment
60	T1S,	R98W	S19, NE¼ SE¼					Mano fragment
61	T1S,	R98W	S19, NE¼ SE¼					Mano
62	T1S,	R98W	S19, SE¼ SE¼			1f	2	
63	T1S,	R98W	S20, NE¼ NW¼				2	
68	T1S,	R98W	S8 , SW¼ SE¼			1f	12	
69	T1S,	R98W	S17, NE¼ NW¼				1	
73	T1S,	R98W	S18, NE¼ SE¼	1f			1	Anvil, Mano
74	T1S,	R98W	S18, NE¼ SE¼					2 Mano fragments
75	T1S,	R98W	S18, NE¼ SE¼				3	
76	T1S,	R98W	S17, NW¼ SW¼			1f		
77	T1S,	R98W	S18, NE¼ SE¼					Toolstone
80	T1S,	R99W	S13, SW¼ SE¼	1f	2f	1	30	Mano fragment
85	T1S,	R99W	S13, SW¼ SE¼		2f	5f	96	
86	T1S,	R99W	S13, NE¼ SE¼	1f	3f	1		Hammerstone frag-
						2f	72	ment, 2 Mano fragments

Table 2.5.2-3 (Continued)

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
87	T1S,	R98W	S30, NW¼ NE¼	1f			37	
88	T1S,	R98W	S30, NW¼ NW¼	1f		2		Mano
90	T1S,	R99W	S36, NE¼ SW¼	4f	1f	1		
						1f	20	Mano
91	T1S,	R99W	S11, SW¼ SE¼				1	
92	T1S,	R98W	S8 , SW¼ SE¼			1		
						1f*	1	
93	T1S,	R98W	S7 , NW¼ SW¼					Mano fragment
105	T1S,	R99W	S14, SE¼ SE¼		1f		1	
106	T1S,	R98W	S29, SW¼ NW¼				1	
107	T1S,	R99W	S36, SE¼		2f		14	
108	T1S,	R99W	S14, SE¼ SE¼				4	
109	T1S,	R99W	S36, NE¼ NE¼	2	2f		84	Mano
110	T1S,	R99W	S25, NE¼ SE¼			1		
111	T1S,	R98W	S30, SE¼ SW¼	1f	2f	4	102	Drill fragment, Mano fragments, toolstone
112	T1S,	R98W	S30, SW¼ SE¼				2	Toolstone
113	T1S,	R98W	S30, SW¼ SW¼	1f	1		7	
114	T1S,	R98W	S30, SE¼ SE¼				6	
115	T1S,	R98W	S30, SE¼ SE¼			1	19	Drill fragment
116	T1S,	R98W	S20, SW¼ NE¼	2	1f		13	Toolstone
117	T1S,	R98W	S29, NE¼ NW¼		2f		11	Mano fragment
118	T1S,	R98W	S7 , NE¼ NE¼	1f	2f	1f	25	2 Mano fragments
119	T1S,	R99W	S13, SW¼ NE¼				12	2 Mano fragments
120	T1S,	R99W	S11, SE¼ NE¼				2	
121	T1S,	R99W	S2 , SW¼ SE¼					Mano fragment
122	T1S,	R99W	S12, NE¼ NW¼			1f	6	
123	T1S,	R99W	S11, SW¼ NE¼		1f	1		Core, 2 Mano frag-
						1f	21	ments, toolstone
124	T1S,	R99W	S15, NW¼ NW¼	1			72	
125	T1S,	R98W	S19, SW¼ SE¼			1		
126	T1S,	R99W	S15, SE¼ NE¼				1	
127	T1S,	R99W	S11, SW¼ SW¼	1			2	
128	T1S,	R99W	S15, NW¼ NE¼			2f	14	3 Mano fragments, 1 hammerstone

* Identifiable fragmentary tool

Table 2.5.2-4 Field site number, site location and initial material culture analysis for archaeological sites located June through September 1975 off-tract outside Tract C-a periphery and 84 Mesa.

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
19	T2S,	R99W	S13, SW¼ NW¼	2f*	1			
					1f	1f	18	Mano, hammerstone
78	T1S,	R98W	S21, NW¼ NW¼	1f		1f	5	Mano fragment
79	T1S,	R98W	S16, SE¼ SW¼		1f			
89	T2S,	R100W	S13, SE¼ NE¼		1f			
96	T1S,	R98W	S9 , SE¼ SW¼					Mano fragment
98	T1S,	R98W	S5 , SE¼ SE¼				1	Mano
99	T1S,	R98W	S9 , NW¼ NW¼					Mano fragment
100	T1S,	R99W	S21, SE¼ SW¼				5	Mano fragment
101	T1S,	R99W	S21, NW¼ SE¼	1				
102	T1S,	R99W	S21, NW¼		1f			
129	T1S,	R98W	S32, NW¼ NE¼	4f	1f	1f	92	
130	T1S,	R98W	S9 , NE¼ SE¼					2 Mano fragments
131	T1S,	R98W	S9 , SE¼ SE¼					1 Mano fragment
132	T1S,	R98W	S9 , SE¼ SE¼		1f		14	
133	T1S,	R98W	S10, SW¼ SW¼					Mano fragment
134	T1S,	R98W	S9 , SE¼ SW¼				5	
135	T1S,	R98W	S21, NE¼ SW¼			1		
136	T1S,	R98W	S22, NW¼ NW¼			1		
137	T1S,	R98W	S32, NE¼ NW¼	1f				Mano fragment
138	T1S,	R98W	S31, SW¼ SW¼	1f			2	Mano fragment
139	T1S,	R98W	S10, SW¼ SE¼		1f		51	
140	T1S,	R99W	S9 , NW¼ NE¼	2f	4f	2		
						1f	95	Drill, 5 tool fragments, Mano, 4 Mano fragments, toolstone
141	T1S,	R99W	S9 , NW¼ NE¼	1f	1f	1	7	2 Mano fragments
142	T1S,	R99W	S10, NW¼ NW¼			1		3 potsherds, core, hammerstone, Mano, 10 Mano fragments
144	T1S,	R99W	S10, NE¼ NW¼	2f		2f	28	Mano fragment
145	T1S,	R99W	S10, NW¼ SW¼	1f	1f	3f	15	
147	T1S,	R98W	S10, SE¼ NE¼		1f	1		
						4f	23	
148	T1S,	R98W	S11, NW¼ NW¼	3f	2f	3f	52	
149	T2S,	R98W	S4 , SW¼ SW¼			1	3	1 potsherd

Table 2.5.2-4 (Continued)

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
150	T1S,	R98W	S32, NE¼ SE¼			2f	4	
151	T1S,	R98W	S33, SW¼ SE¼		3f	1	4	Mano fragment
152	T1S,	R98W	S11, NW¼ SE¼	1	1f	1	12	Mano, hammerstone, 1 hammerstone fragment
153	T1S,	R98W	S11, NE¼ NE¼	1f	4f	7	118	Mano fragment
154	T1S,	R98W	S2 , SW¼ SW¼	1		1		
				2f*	1f	2f	8	Mano
155	T1S,	R98W	S2 , SW¼ SW¼				5	
156	T1S,	R98W	S2 , SW¼ SW¼				4	
157	T1S,	R98W	S2 , NE¼ SW¼				21	
158	T1S,	R98W	S11, NW¼ NW¼				5	
159	T1S,	R98W	S11, NW¼ NW¼			4	9	Hammerstone, 3 Mano fragments
160	T1S,	R98W	S16, NE¼ NE¼	1f	4f	4f	42	1 potsherd, 1 Mano, 3 Mano fragments
161	T1S,	R98W	S16, SW¼ NE¼		1f		4	
162	T1S,	R98W	S34, NW¼					Mano fragment
163	T1S,	R98W	S33, NE¼ NE¼				4	Mano fragment
164	T1S,	R99W	S8 , NE¼ NE¼	2f	4f		10	Hammerstone, 6 Mano fragments
165	T1S,	R98W	S16, SE¼ SE¼	2f	1f		5	Core
166	T1S,	R98W	S1 , SW¼ NW¼		1	1	9	Mano, Mano fragment
167	T1S,	R98W	S35, SW¼ SW¼	2f	1f		2	2 cores, Mano fragment
168	T2S,	R98W	S2 , SE¼ SE¼				3	
169	T1S,	R97W	S19, SW¼ SW¼				2	Mano fragment
170	T1S,	R97W	S18, SE¼ NW¼				1	
171	T1S,	R98W	S29, NE¼ NE¼				3	
172	T1S,	R98W	S28, NW¼ NW¼				3	
173	T2S,	R98W	S6 , NW¼ NW¼			3	5	
174	T1S,	R98W	S31, NW¼ NE¼		1f	2f	10	Mano, Mano fragment
175	T1S,	R98W	S31, NW¼ NE¼		1f	2f	10	Mano, Mano fragment, 5 tool fragments
176	T1S,	R98W	S31, NE¼ NE¼			1	7	Mano, tool fragment, core
177	T1S,	R98W	S32, NW¼ NW¼					Structures

Table 2.5.2-4 (Continued)

Field Number	Township	Range	Section	Point	Knife	Scraper	Flakes	Other
178	T2S,	R98W	S6 , NE¼ NE¼	1f		1		
179	T1S,	R98W	S32, SW¼	1f			3	Tool fragment
180	T1S,	R98W	S31, SE¼	1f			2	Tool fragment
181	T1S,	R98W	S32, SW¼ NE¼		1f		11	Tool fragment
182	T1S,	R98W	S31, SE¼ SE¼				38	Tool fragment
183	T2S,	R99W	S14, NE¼ SW¼					Tool fragment
184	T2S,	R99W	S23, NE¼ SW¼				1	Tool fragment
185	T2S,	R98W	S19, NW¼ SW¼			1	1	Tool fragment
186	T1S,	R98W	S1 , SW¼ NE¼	2f*	1f	3f	36	Hammerstone, Mano fragment, 4 tool fragments
187	T1S,	R98W	S36, SE¼				1	Hammerstone, Mano
188	T1N,	R98W	S25, NE¼	1f		1	10	Mano, Mano fragment, 5 tool fragments
189	T2S,	R98W	S3 , NW¼	1f	1f	1	45	2 tool fragments
190	T2S,	R98W	S4 , SE¼ NE¼		1f	5	41	3 Mano fragments, 3 tool fragments
191	T2S,	R98W	S4 , NW¼ NE¼	1				
				1f			8	Mano, 2 Mano fragments, 2 tool fragments
192	T1N,	R98W	S23, NW¼ NW¼			1	1	
193	T1N,	R98W	S23, NE¼ NW¼	1f		1	14	Tool fragment, Mano fragment
194	T1N,	R98W	S13, W½	3f		2	3	3 tool fragments, 2 hammerstone fragments, 3 tool fragments
195	T1S,	R98W	S34, NE¼ SE¼	1				
196	T1N,	R98W	S31, NW¼ NE¼		1			
					1f	2f	10	Mano, Mano fragment, 3 tool fragments

* Identifiable fragmentary tool

Sites yielding a concentration of tool wastage and artifacts were called lithic scatters. These represent some permanence of occupany, at least long enough to produce, lose or discard the materials found. These areas may have been used intensively during a short period of time or may represent a camp that was repeatedly used over a period of years. No sites appeared to have been year-round camps, but merely gathering places for utilization of a particular resource. The aboriginal occupation of Tract C-a and the surrounding Piceance Basin was probably seasonal. The Basin was probably not used during the winter and spring because of inclement weather in the winter and poor hunting possibilities in the spring. The combination of hunting tools, meat and skin processing tools, and tools used for the preparation of vegetal materials would suggest that the area was occupied from summer through fall. Scarcity of food probably precludes the presence of large groups of people. The types of tools would suggest two patterns of exploitation that can be interlocked in terms of time. In the late summer and fall, hunting and gathering could have been practiced simultaneously. Hunting was probably performed by men, and gathering by women and children except during highly successful seasons when processing of game and gathering may have been shared. The area was primarily used as a source of game and vegetal products. Good harvests of pinyon nuts probably drew people into the area in some instances. The term "Piceance" locally translated from the Ute as "land of tall grass" may indicate some utilization of grasses, although most meadow species are not commonly used for food. Agriculture was probably not practiced in the Basin, although it may have been in lowland areas to the north and east along the major drainages.

Hunting was a primary concern, but the killing and butchering of deer or elk leaves very little evidence. Once the meat has been stripped from the bones, or the animal butchered, the meat utilized and the bones discarded, the evidence disappears through natural processes. Soil formation and the covering of the bones by alluvial action did not seem to occur. No kill sites were found.

Field analysis indicates there were at least four periods of occupation of the area: an Archaic period followed by the Fremont culture, then Ute and finally Anglo.

The Archaic or Desert Culture was initially defined in Utah. Similar material has been found in the high valleys and drainages on the Western Slope of Colorado. Similar tools have been found in southern Wyoming and along the Front Range of Colorado. The time depth in Utah can be extended back at least 10,000 years.

The social unit seems to have been a family of two or perhaps three generations including husbands and wives and dependent children. Seasonal opportunities dictated the movement of the

group and any resource that produced edible food was exploited. A considerable knowledge of natural history, seasonal patterns of game movements and ripening times of various plants was needed. Material culture was geared to frequent changes in location. Flexible containers of hide or basketry were used instead of ceramics. Other types of equipment were practical and portable. Clothing was minimal and housing only constructed when a subsistence item was plentiful enough to support the group in one place for a period of time. Caves or overhangs were used when they occurred. Exploitation patterns indicate that, in addition to game and plants, fish, insects, waterfowl, rodents and reptiles were eaten. Artifacts from this sample that can be identified with the Archaic are primarily projectile points. Dating of this occupation could extend back several thousand years, but this inference cannot be positively confirmed from surface material.

The Fremont Culture, originally defined from Utah and northwestern Colorado, continues the Archaic pattern of subsistence. Agriculture and pottery were diffused into the area from the Southwest. Prior to A.D. 400, there was considerable influence from the Four Corners region. Five subdivisions of that pattern have been identified in Utah and two border the northwestern portion of Colorado. One, the Uinta area, is located in northeastern Utah and the San Rafael, the other, is in eastern central Utah. The time span for these periods is from approximately A.D. 450 to 1400. These groups revealed less puebloan contact.

Most artifact material shows a continuation from the Archaic. Projectile points decreased in size and differed in outline, but most tools were not altered. Ornaments and pottery were added and leather footgear and clothing become more common. Clay figurines of men and women have been found in several areas, but not in the Tract C-a area. While agriculture expanded the economic base, hunting and gathering were still most important. Social patterning did not differ significantly from that of the Archaic.

The Meeker region is noted for the Ute massacre at Meeker's trading post. The time and extent of the Ute occupation is less well known. The Ute may well be a continuation out of Fremont, with the addition of the horse and items of European manufacture. Several sites were found which had Wickiups or the conical frames for small houses. The shape is tipi-like, with the use of smaller brush and juniper bark as the covering. Some are still standing and show the interlocked main frame elements. Unfortunately, artifacts at these sites were very scarce and do not aid in dating the structures. At one site, a butcher knife was found; however, this could have been lost by Anglos.

Recent historic material is largely that left by deer hunters. Several early ranches, houses and a school are near the study area. There is a historic horse trap on 84 Mesa that has not been in use for some time. The majority of Anglo occupation is in the Ryan Gulch and Yellow Creek areas.

2.5.3 Revegetation

2.5.3.1 Objectives

The extraction and processing of oil shale rock from Tract C-a will result in the creation of processed oil shale disposal piles. As an integral part of the rehabilitation plans for lands affected by oil shale processing, these disposal piles are to be reclaimed in such a way as to be compatible with the existing landscape and the biota which inhabit it. Revegetation methods should be available at the onset of shale processing to assure that this compatibility is realized. The overall goal of a revegetation plan for Tract C-a disposal piles is to develop self-sustaining plant (and animal) communities in equilibrium with local climate and substrate conditions, and not wholly unlike the existing vegetation. Although considerable research has been done on methods of revegetating semi-arid lands and processed oil shale, it is not specific enough to meet the objectives set forth above for revegetation of Tract C-a disposal piles. Thus, a series of long-term experiments to fill existing data voids are to be conducted. The initial revegetation program is designed to run from Fall 1975 through Winter 1978. It will involve the application of a number of treatments, such as mulching types, fertilizer schedules, and a species combination to a number of artificially created substrates in field test plots designed to simulate, to some extent, processed shale disposal piles. Based on the results of these studies, additional experiments will be determined in conjunction with the Area Oil Shale Supervisor.

The characteristics of processed oil shale disposal piles, as envisioned at this time, are pertinent to the revegetation program. The design elements of these disposal piles are being developed jointly by engineers and ecologists in an attempt to create substrates which are conducive to successful revegetation. Tract C-a revegetation experiments are discussed in light of the planned disposal pile characteristics and in light of existing knowledge about revegetation of the area and substrates incorporating processed oil shale.

2.5.3.2 Methods

a. Design of Disposal Piles - As a basis for designing initial revegetation experiments, it was necessary to consider the characteristics of processed oil shale piles to be revegetated and the kinds of information available on revegetation techniques for semi-arid lands and spent oil shale substrates in particular.

Preliminary designs call for a typical disposal pile to have the following strata, from top to bottom:

10 to 15 cm (4 to 6 inches) of topsoil
15 to 30 cm (6 to 12 inches) of topsoil
30 to 60 cm (~6 inches) of crushed rock] "overburden"
60 to 100 cm (~2 to 3 feet) of large boulders]
150 cm (~5 feet) of 95% compacted processed oil shale
0 to several hundred meters (0 to several hundred feet) of 80% compacted processed oil shale
150 cm (~5 feet) of 95% compacted processed oil shale
(The above values represent minimum depths for each strata.)

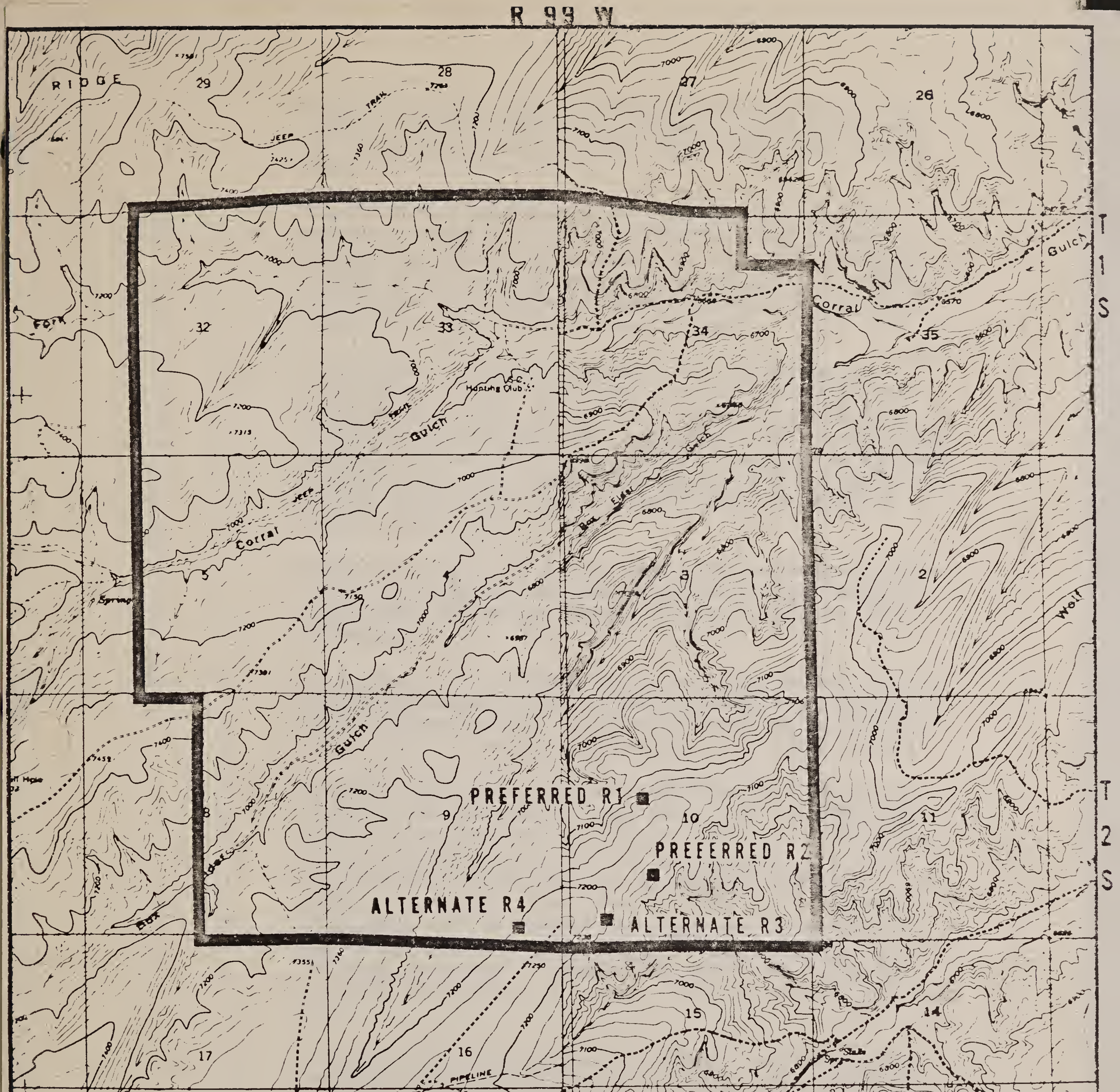
Slopes will be recontoured to blend with the natural landscape, with slopes of not more than 33% (3:1) where revegetation is planned. Catchment basins will be constructed to collect excess runoff. Topsoil substrate and crushed rock will probably be obtained from the same location as the disposal piles.

The configuration and internal characteristics of disposal piles as described above should provide an adequate rooting medium to support plant cover comparable to pre-mining conditions. Topsoils will assure reasonable levels of organic matter and nutrients and provide a residual seed and rhizome source while subsoils should retain moisture for utilization during periods when evaporation normally exceeds precipitation. The overburden and/or quarried rock layers are designed to: 1) reduce mass movement of soils, 2) break capillary migration of dissolved salts from the processed oil shale up into the active rooting zone where excess salts could inhibit plant growth, and 3) inhibit contact of roots with spent oil shale where toxic elements may be incorporated into plant tissues and subsequently ingested by herbivores.

Although the precise location of disposal piles resulting from Tract C-a mining has not been determined, preliminary plans suggest that they will be situated in the 84 Mesa area (T1S, R99W, Section 23 and 24), to the northeast of the tract. Soils on the proposed offsite disposal area are similar to those found on the revegetation site (SCS, 1975). The vegetation is predominantly sagebrush and pinyon-juniper.

b. Selection of Species - A mixture of species which will provide a greater stability and a greater diversity of food and cover for local fauna will be used.

c. Location of Test Sites - Location of preferred and alternate test sites are presented in Figure 2.5.3-1. All sites are



LEGEND

▬ TRACT OUTLINE

■ 1975 REVEGETATION TEST PLOTS

GULF - STANDARD (INDIANA)

RIO BLANCO OIL SHALE PROJECT

TRACT C-a

RIO BLANCO COUNTY, COLORADO

0 3000

situated on side slopes, between elevations of 2160 and 2200 m (7100 and 7200 feet) adjacent to Wolf Ridge Road in the southeast corner of the tract (T1S, R99N, Section 10).

The first year experiments will utilize two sites on opposing slopes at comparable elevations and steepness to test for the effect of aspect on revegetation success. Trials in the two subsequent years will utilize a single site on the slope having the more extreme drought conditions of the two original sites tested.

d. Plot Layout - Sixteen treatments will be applied to a 10 by 10 m (3.28 by 3.28 feet) plot and replicated three times at each site. Each plot will be surrounded by a 3-m (9.84 feet) buffer zone. Treatments will be allocated randomly in each of three complete blocks located adjacent to each other. The total dimensions of a site sample area will be 55 by 165 m (180.4 by 541.2 feet) or 9,075 m^2 (0.91 ha/2.24 acre).

Within each 10 by 10 m treatment plot a minimum of three 1 by .5 m (3.28 by 1.64 feet) subplots will be randomly established and marked permanently for subsequent data collection.

Test sites will be fenced with four-strand barbed wire to discourage large grazers, primarily wild horses and cows. Raptor perches will be constructed along the periphery of test sites to discourage concentration of small grazers.

e. Seedbed Preparation - Native vegetation will be scraped from the two experimental plot sites prior to substrate mixing and transported to adjacent areas for brush piling. Topsoil [about the upper 15 cm (6 inches) of the soil] and remaining subsoil will be stockpiled separately. The underlying bedrock, consisting of fractured calcareous sandstone, will be removed for a minimum thickness of 46 cm (18 inches), broken up and spread back over the area to simulate overburden. Subsoil and topsoil will then be replaced and graded for sowing. Final grade will approach 3:1.

As part of the site preparation process, an appropriate perimeter will be disturbed around each site, thus bringing the total area of disturbance per site to 1.7 ha (4.3 acrea). Materials (topsoil, subsoil, overburden) which are to be stockpiled temporarily (10 days maximum) will be located in the disturbed perimeter.

f. Sowing Methods - All seed will be drilled into the ground prior to mulching using a conventional grassland drill equipped with a single seed box and agitator. Drilling is preferred to broadcast seeding because less seed is required and greater moisture surrounds the seed during the critical stages of germination. Drilling will result in a spacing of 13 to 18 cm (~5 to 7 inches) between planting rows.

g. Species and Sowing Rates - A composite mixture of grasses, forbs and woody plants (Table 2.5.3-1) will be sown in preference to pure species stands. This mixture will consist of both introduced and native species. The introduced species, especially the wheatgrasses, are quite aggressive and are thus suited to rapid establishment and stabilization of the substrate. In contrast, the less aggressive native species are generally more successful in later stages of plant community development. The suitability of each species as wildlife food and cover, as soil stabilizers and as resistors of drought is presented in Table 2.5.3-1.

For purposes of the 1975 test, approximately 18 kg/ha (16 lbs/acre) of seed will be sown, with grasses and non-grasses (forbs and woody plants) in equal 9 kg (8.1 pound) proportions (Table 2.5.3-1).

h. Treatments - For the 1975 test, a total of 16 treatments will be applied using all possible combinations of the following variables:

- Mulch Type and Application (applied to cover approximately 70% of the soil surface)

  1. No mulch
  2. Hydromulch with wood fiber
  3. Straw mulch followed by crimping
  4. Straw mulch with netting

- Fertilizer Application (10-5-5 applied at a rate of 180 kg/ha (160 lbs/acre)

  1. No fertilizer
  2. Fertilizer at time of sowing (fall)
  3. Fertilizer at beginning of first full growing season
  4. Fertilizer at time of sowing and at beginning of first full growing season

i. Plant Response Parameters - The following plant response parameters will be measured for each treatment:

Table 2.5.3-1 Plant species suitability and recommended sowing rates kg/ha, lbs/acre of viable seed for species utilized in revegetation experiments on oil shale Tract C-a, Rio Blanco County, Colorado

Species	Suitability Rating[a]	1975 and 1976 Seeding Rates	
GRASSES		kg/ha	lbs/acre
Luna pubescent wheatgrass (Agropyron trichophorum var. luna)	2,4,6,8,9	1.7	1.5
Rosana western wheatgrass (Agropyron smithii var. Rosana)	4,5,8,9	1.7	1.5
Sodar streambank wheatgrass (Agropyron riparium var. Sodar)	3,5,8,9	1.7	1.5
Indian ricegrass (Oryzopsis hymenoides)	2,4,5,7,9	0.7	0.6
C-43 basin wild rye (Elymus cinereus var. C-43)	2,4,5,7,11	1.7	1.5
Green needlegrass (Stipa viridula)	2,5,7	1.7	1.5
FORBS			
Lewis flax (Linum lewisii)	2,5	0.6	0.5
Lutana cicer milkvetch (Astragalus cicer var. Lutana)	6,11	0.6	0.5
Utah sweetvetch (Hedysarum utahensis)	2,5	0.6	0.5
Madrid yellow sweetclover (Melilotus officinalis var. Madrid)	2,4,5,9,11	0.6	0.5
Rocky Mountain penstemon (Penstemon strictus var. bandera)	3,5,9	0.6	0.5
Scarlet globemallow (Sphaeralcea coccinea)	3,5,9	0.6	0.5
SHRUBS			
Big sagebrush (Artemisia tridentata)	2,5,9,10,11	0.2	0.2
Little rabbitbrush (Chrysothamnus viscidiflorus)	2,4,5,9,11	0.2	0.2
Bitterbrush (Purshia tridentata)	1,5,9,10,11	1.1	1.0
Mountain mahogany (Cercocarpus montanus)	1,5,10	0.6	0.5
Fourwing saltbush (Atriplex canescens)	1(seeds), 3, 4,5,9	1.1	1.0

Table 2.5.3-1 (Continued)

Species	Suitability Rating[a]	1975 and 1976 Seeding Rates	
		kg/ha	lbs/acre
SHRUBS (Continued)			
Winterfat (*Eurotia lanata*)	1,5,10	0.6	0.5
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	3,5,9,10,11	0.6	0.5
Snowberry (*Symphoricarpos oreophilus*)	2,4,5,10	0.6	0.5
Squaw bush (*Rhus trilobata*)	2,4,5,9,10,11	0.6	0.5
TREES			
Utah juniper (*Juniperus osteosperma*)	3,5,9,10,11	0.1	0.1
Pinyon pine (*Pinus edulis*)	3,5,9,11	0.1	0.1

[a] Suitability ratings are:

1. Highly palatable
2. Moderately palatable
3. Unpalatable
4. Soil stabilizer
5. Native to Colorado[b]
6. Introduced species
7. Bunch grass
8. Sod grass
9. Drought resistant
10. Browse
11. Cover for game

[b] Underlining indicates species observed on site as part of the environmental baseline studies (Limnetics, Inc., June 1975).

1. Number of emerged seedlings per plot,
2. Number of surviving seedlings per plot,
3. Above-ground biomass,
4. Percent cover, and
5. Vigor

Table 2.5.3-2 gives the season of measurement for each parameter and the taxa involved. Photographs will be taken from fixed points in at least one replicate of each treatment at the times of data collection. A qualitative measure of alien species success will be obtained from in-situ counts of germination in buffer areas and from germination rates in soil samples collected from buffer areas and placed in the greenhouse.

j. Statistical Analysis - For the dependent variables of number of emerged seedlings, number of surviving seedlings and biomass at a particular site and in a particular year, the following analysis of variance is given:

Source of Variation	Degrees of Freedom	
Block	2	
Treatment	15	
Mulch		3
Fertilizer		3
Mulch x Fertilizer		9
Error A	30	
Species	22	
Treatment x Species	330	
Species x Mulch		66
Species x Fertilizer		66
Species x Fertilizer x Mulch		198
Error B	704	
Total	1103	

k. Environmental Data - Soils and climatic data will be collected periodically during the study period in order to attempt to establish more closely the causal links between plant response to varying treatments and the soil and climatic factors eliciting these responses. Soil moisture will be measured using standard gravimetric techniques from soil samples collected at 15 cm intervals throughout the soil column. Soil moisture determinations will be made periodically on three samples at each site during the growing season.

Soil samples will be collected at each site and pH, exchangeable sodium percentage, available nitrogen, phosphorus, and potassium, electrical conductivity, percent organic matter and concentrations of zinc and molybdenum will be determined with standard laboratory techniques.

Table 2.5.3-2 Plant response parameters measured in initial revegetation studies on oil shale Tract C-a, Rio Blanco County, Colorado, 1976-1978

Parameter	Time of Measurement	Taxa Involved
Number of emerged seedlings per plot	first spring following fall planting, i.e., beginning of first growing season	each planted species
Number of surviving seedlings per plot	end of first growing season	each planted species
Above-ground biomass (dry wt.)	end of third growing season	total seeded species, total alien species, individual seeded species contributing bulk of biomass
Percent cover	end of third growing season	each species
Vigor	end of first, second, and third growing seasons	each planted species

Two samples will be collected at each site during each growing season at 15 cm (6 inch) intervals.

1. Revegetation Trials in Years 2 and 3 - Revegetation experiments inititated in Year 2 (Fall 1976) and Year 3 (Fall 1977) will essentially duplicate those initiated in Year 1, except that a layer of Parahoe processed oil shale approximately 15 cm (6 inches) in thickness will be placed over the bedrock and below the simulated overburden. Comparison with Year 1 experiments should provide some insights into the effect of processed oil shale in revegetative success, particularly with regard to the influence of salt and heavy metals.

   Trials 2 and 3 will be conducted on one site (as opposed to two in Trial 1) and will be monitored for a minimum of 3 years as is the case with Trial 1.

   Additional experiments will be determined in conjunction with the Area Oil Shale Supervisor. They will depend in large on results obtained during the initial revegetation program and on the availability of actual processed oil shale.

2.5.5 Trace metals

Soils from two pits sampled by the Soil Conservation Service are currently being analyzed for trace metals. Results are not yet available.